



ELECTRICAL  
& COMPUTER  
ENGINEERING

# ECE-595 Network Softwarization

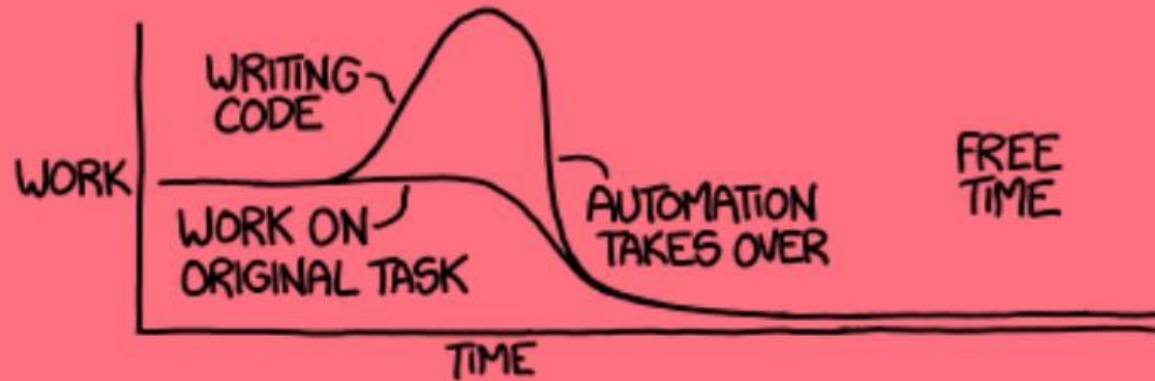
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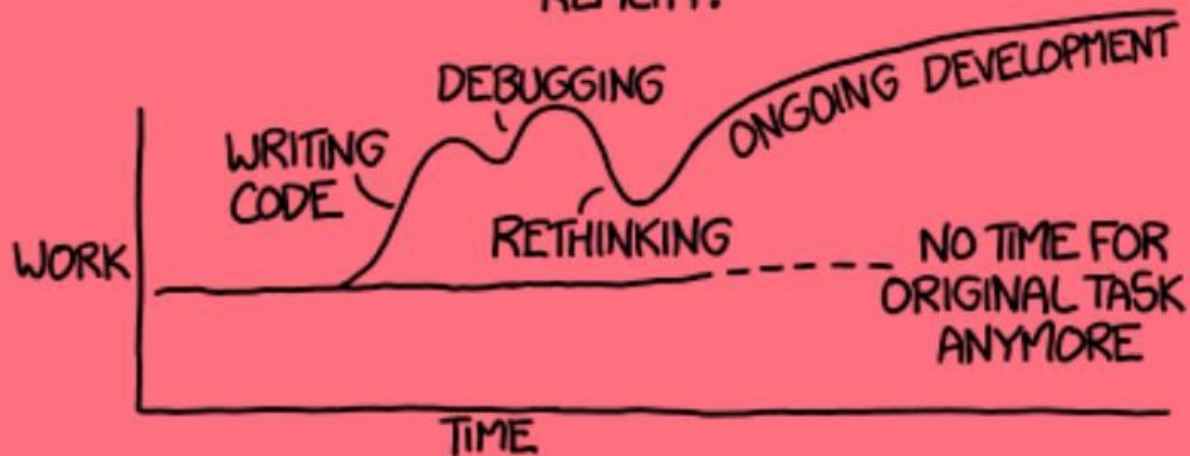
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"I SPEND A LOT OF TIME ON THIS TASK.  
I SHOULD WRITE A PROGRAM AUTOMATING IT!"

THEORY:



REALITY:



# The future of digital service delivery from Digital Service Providers (DSPs)

## Traditional CSP

- Focus on “elephant” mass-market services that can justify the cost & time
- Expensive and slow to get new service to market due to complex OSS/BSS systems, and manual processes



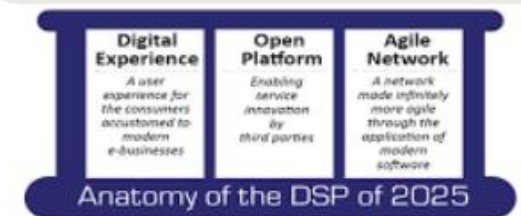
## Cloud Transformation

- Webscales deliver rapid, personalized, on-demand services - leverage cloud automation but mainly over the top delivery
- CSPs starting to evolve with NFV/SDN to speed the delivery of network services



## Future DSP

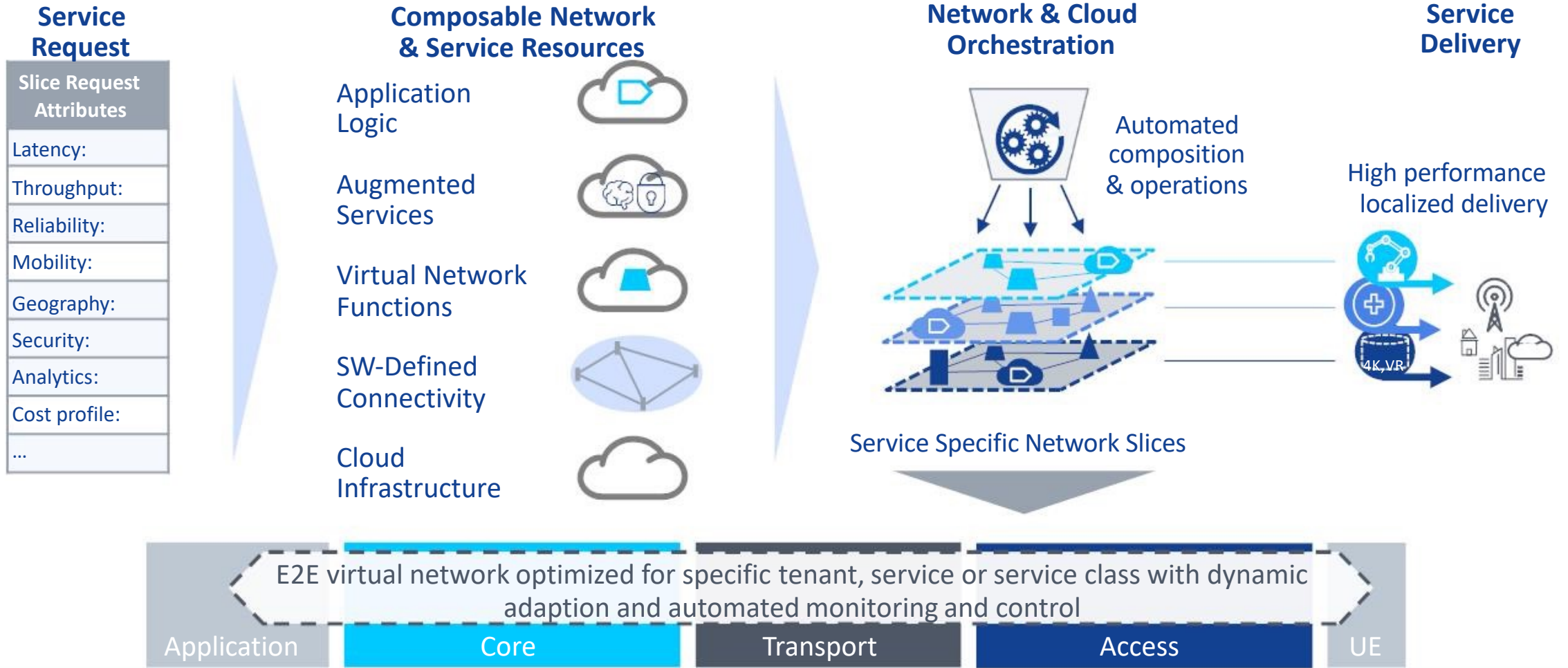
- Digital experience: broad array of new services that combine cloud services and network resources
- Tailor virtual networks for each use case: latency, bandwidth, security, choice of functions
- Agile network: services are rapidly trialed, deployed & scaled
- Open platform: ecosystem of cloud and network players



Source: Analysys Mason

New Markets | Faster New Services | Faster Time to Revenue | Higher Customer Satisfaction

# Network Slicing – The foundation for future value creation

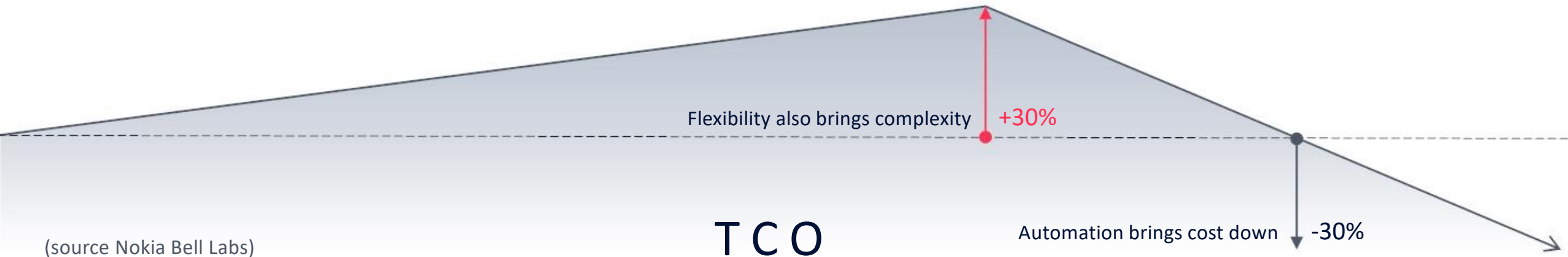


Network slices are end-to-end ‘virtual private services’

# Virtualization and Slicing are not enough

Automation is essential to economics

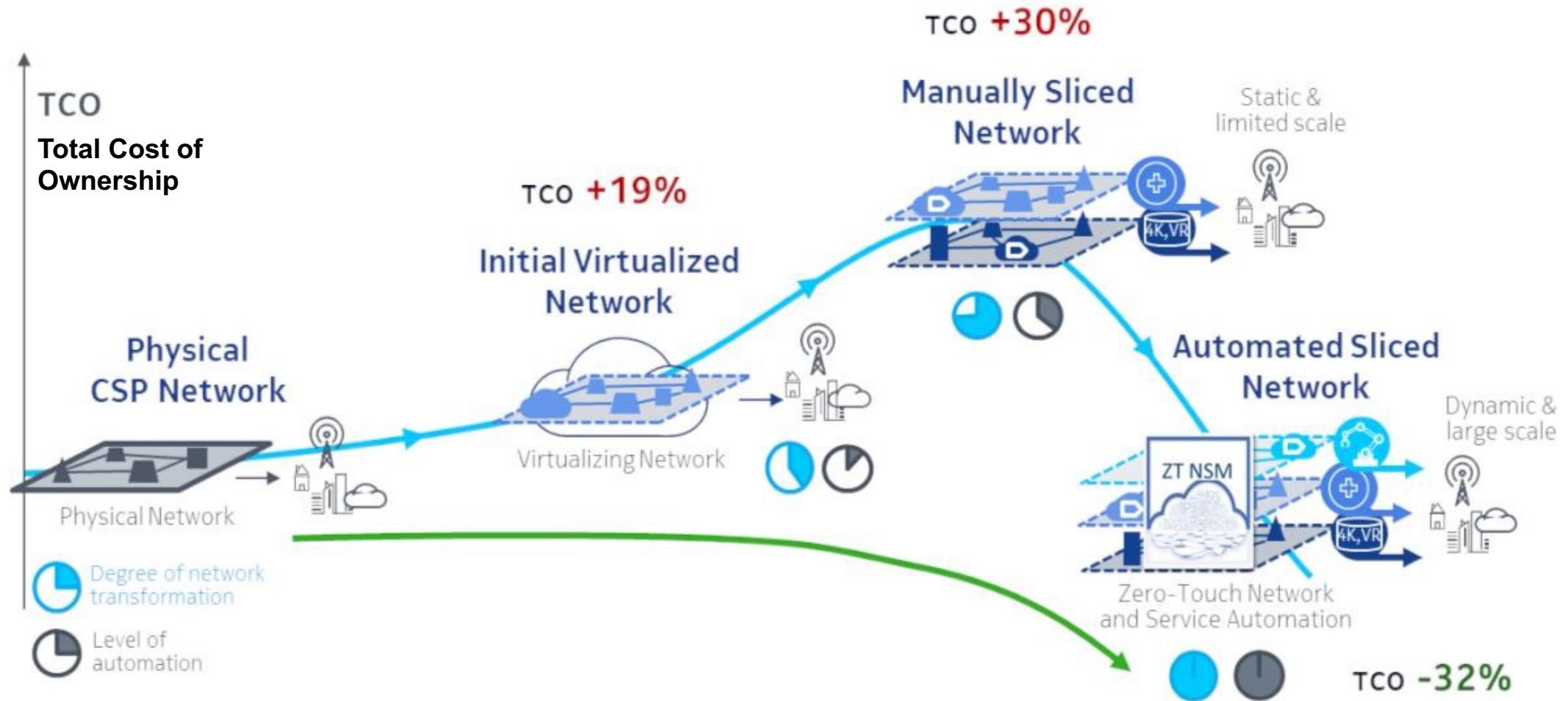
## TRANSFORMATION



(source Nokia Bell Labs)

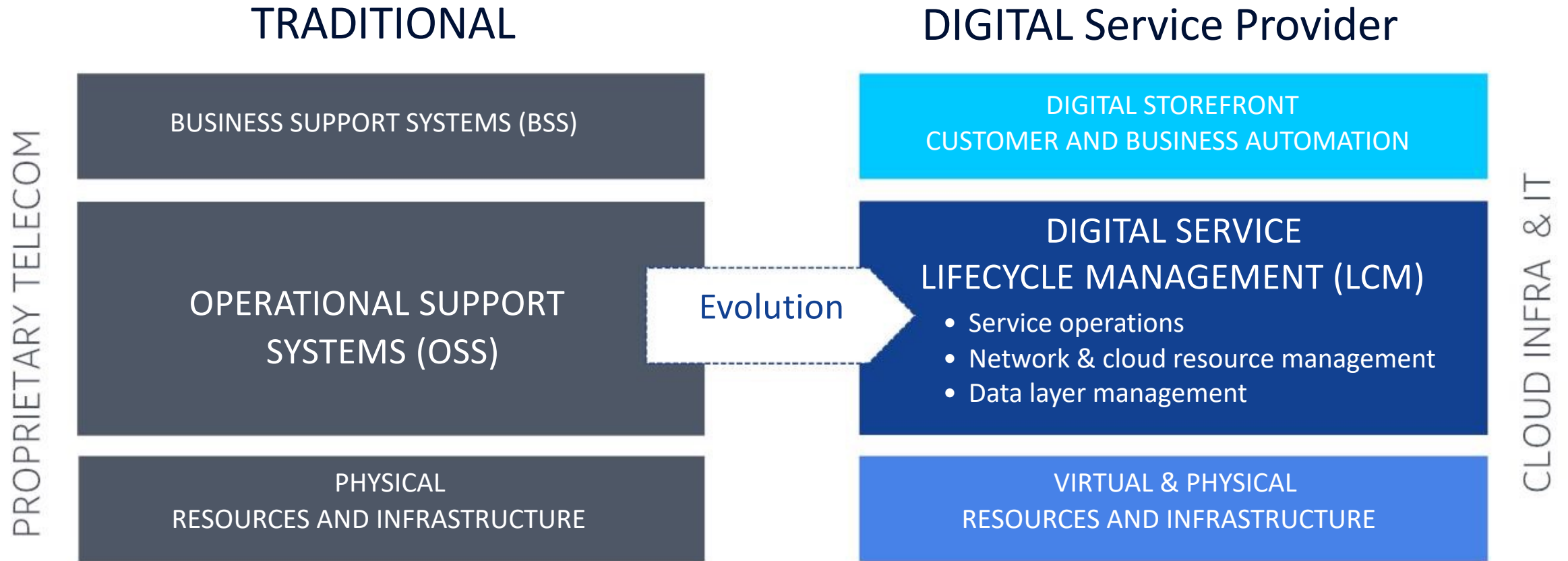


# Network and Service Automation are essential to DSP economics

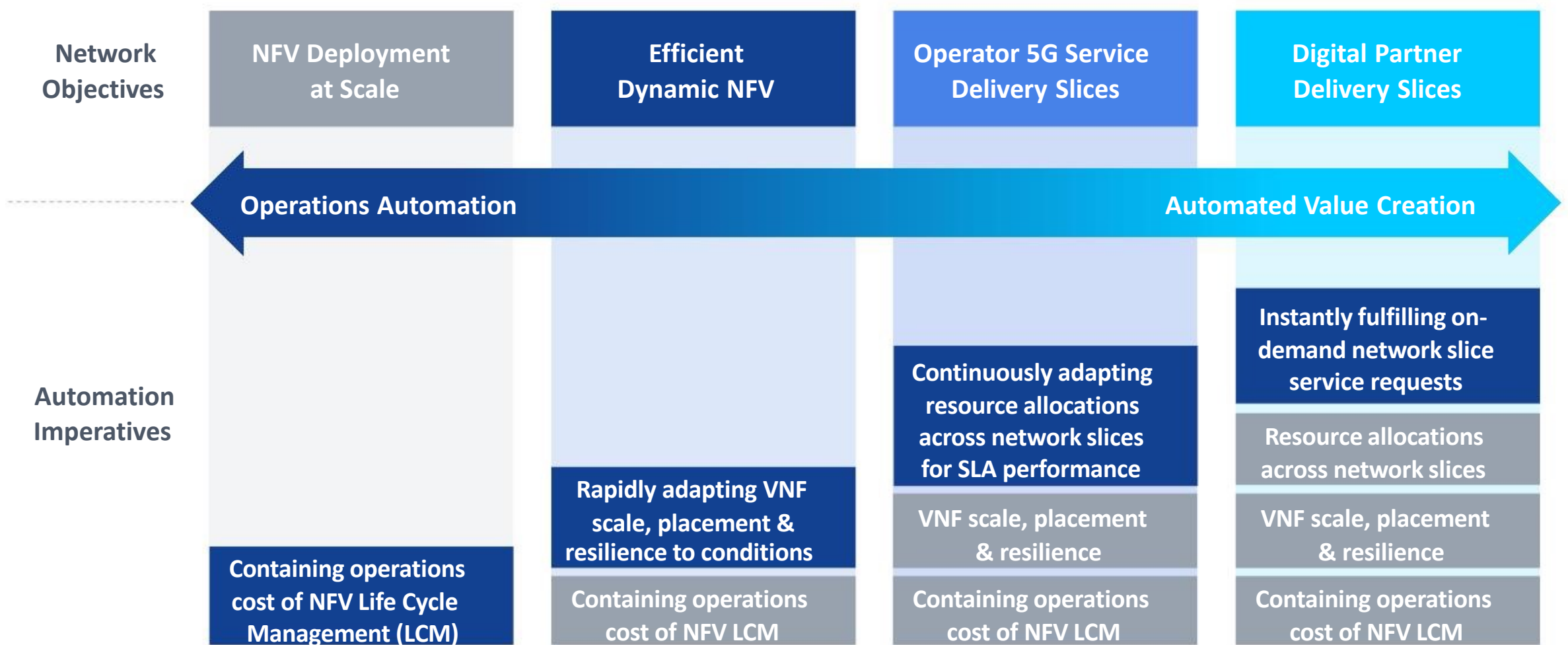


Without E2E automation NFV/SDN & network slicing add significant cost and complexity

# Transformation from CSP to DSP requires a new automation stack



# The essential value path from CSP to DSP



Multiple value stages to the automation transformation

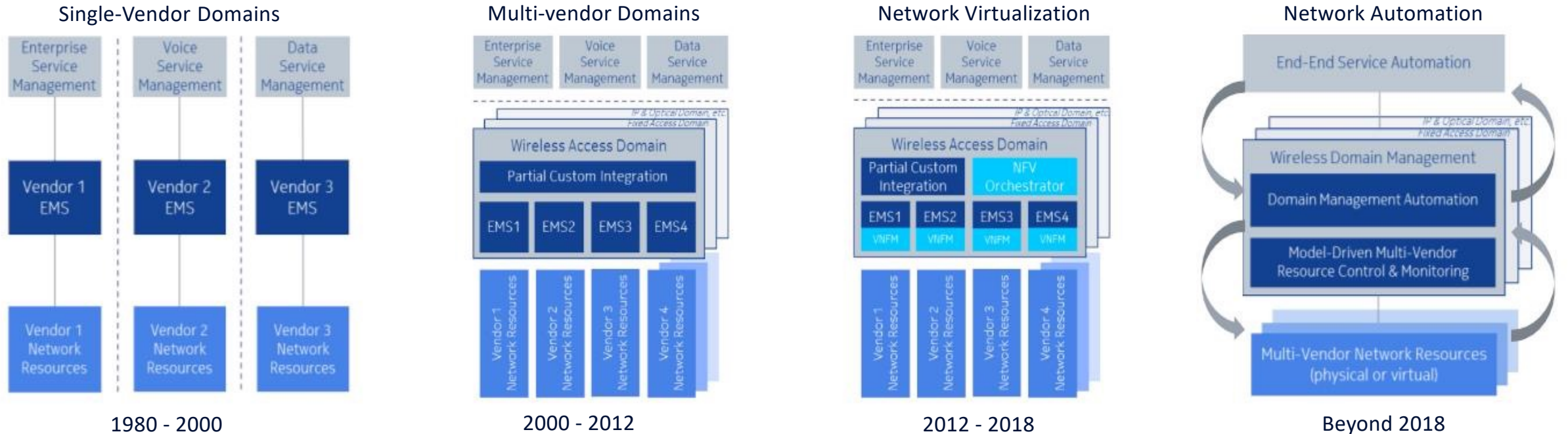


# Evolution of network management architectures

From silos and custom integration to full multi-domain automation




Increasing operational complexity

Operational agility and efficiency



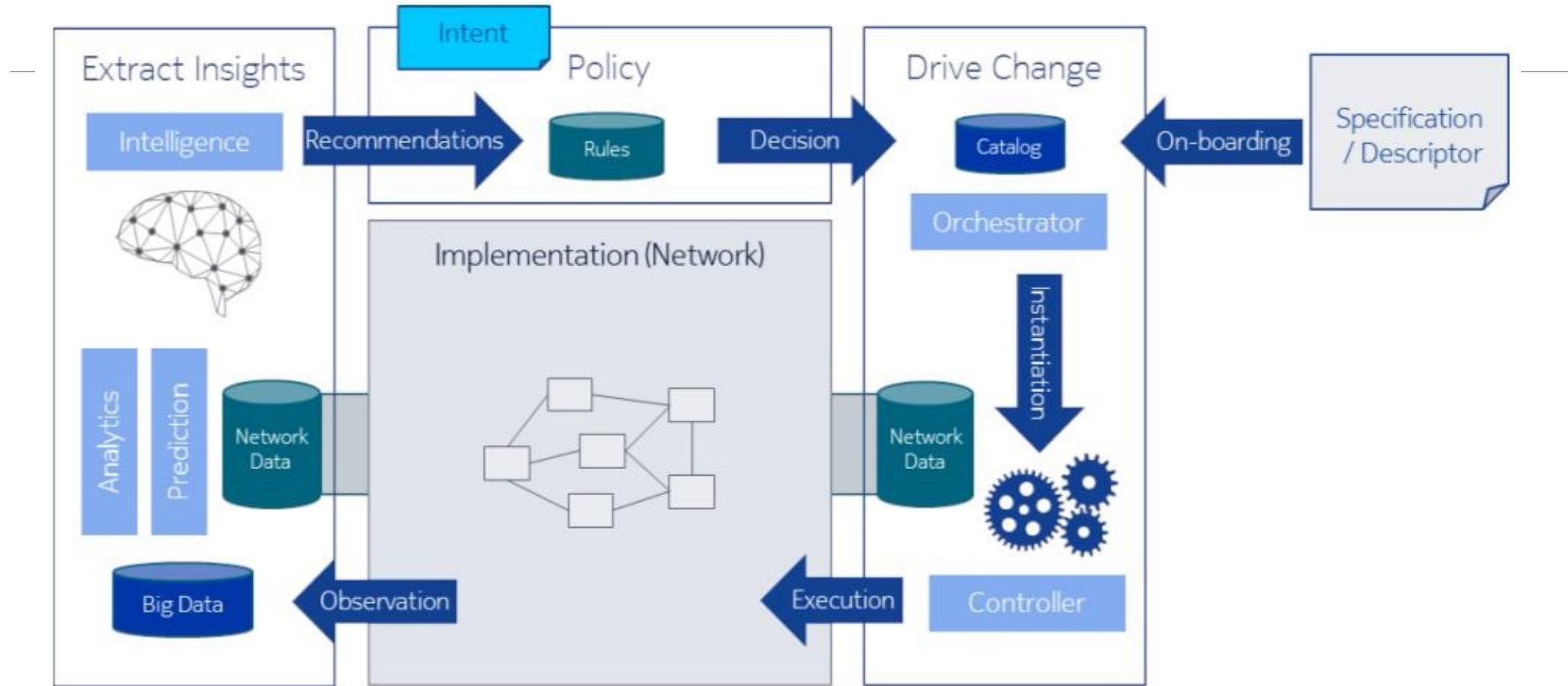
# Evolution of network management automation

From reactivity to zero-touch automation

	Past	Present	Future
Network/service operations	 <b>Reactive</b>	 <b>Proactive</b>	 <b>Zero-Touch</b>
Level of automation	Low: single task	Partially automated processes	Closed-loop network and service automation
Intelligence	Descriptive & diagnostic analytics, for example anomaly detection	Predictive analytics, e.g. for maintenance/repair	Prescriptive analytics & machine intelligence
Network agility	Static network	More dynamic with partial software control overlay	Fully programmable with embedded software control

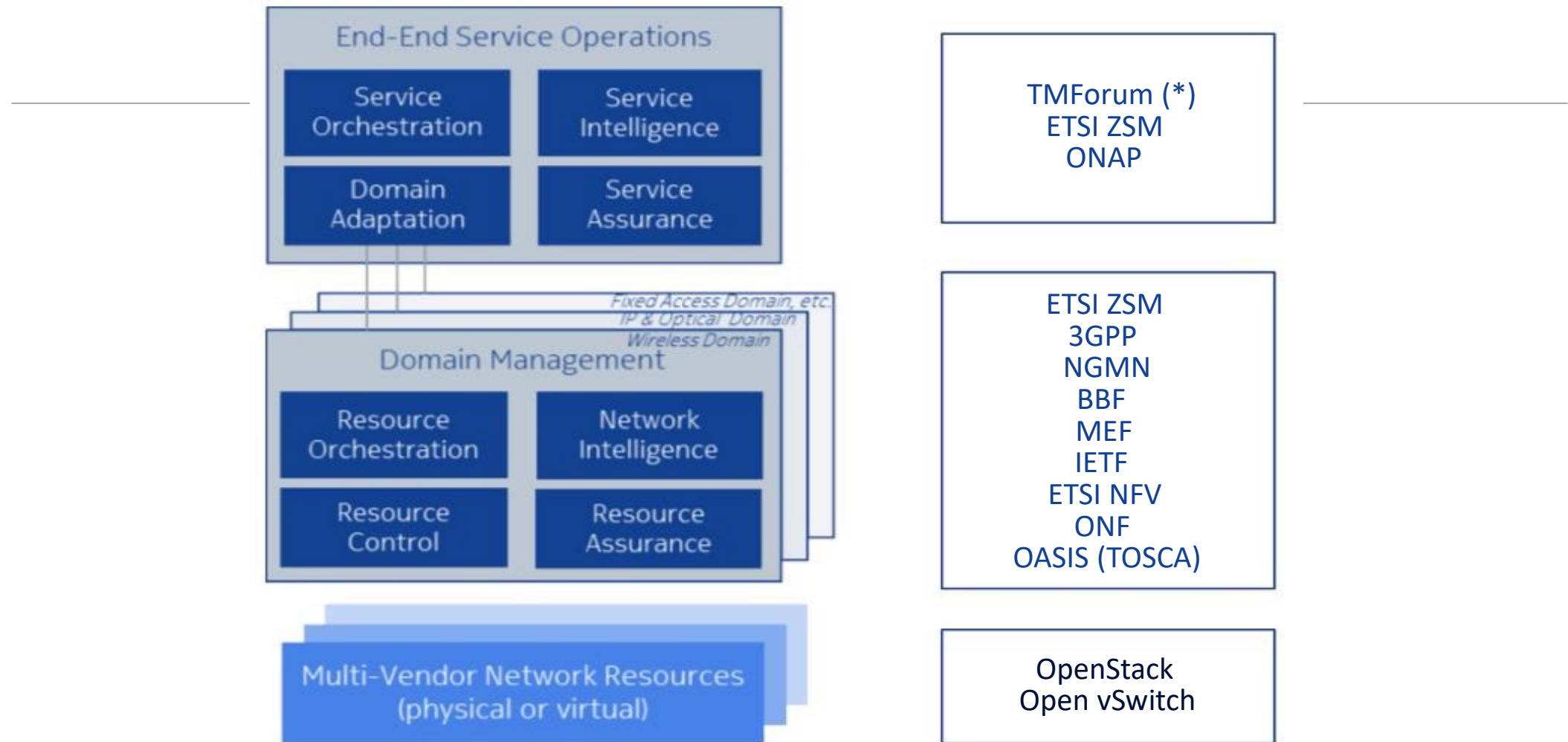
Source: adapted from Analysis Mason

# Closed-loop «Zero-Touch» Network Automation

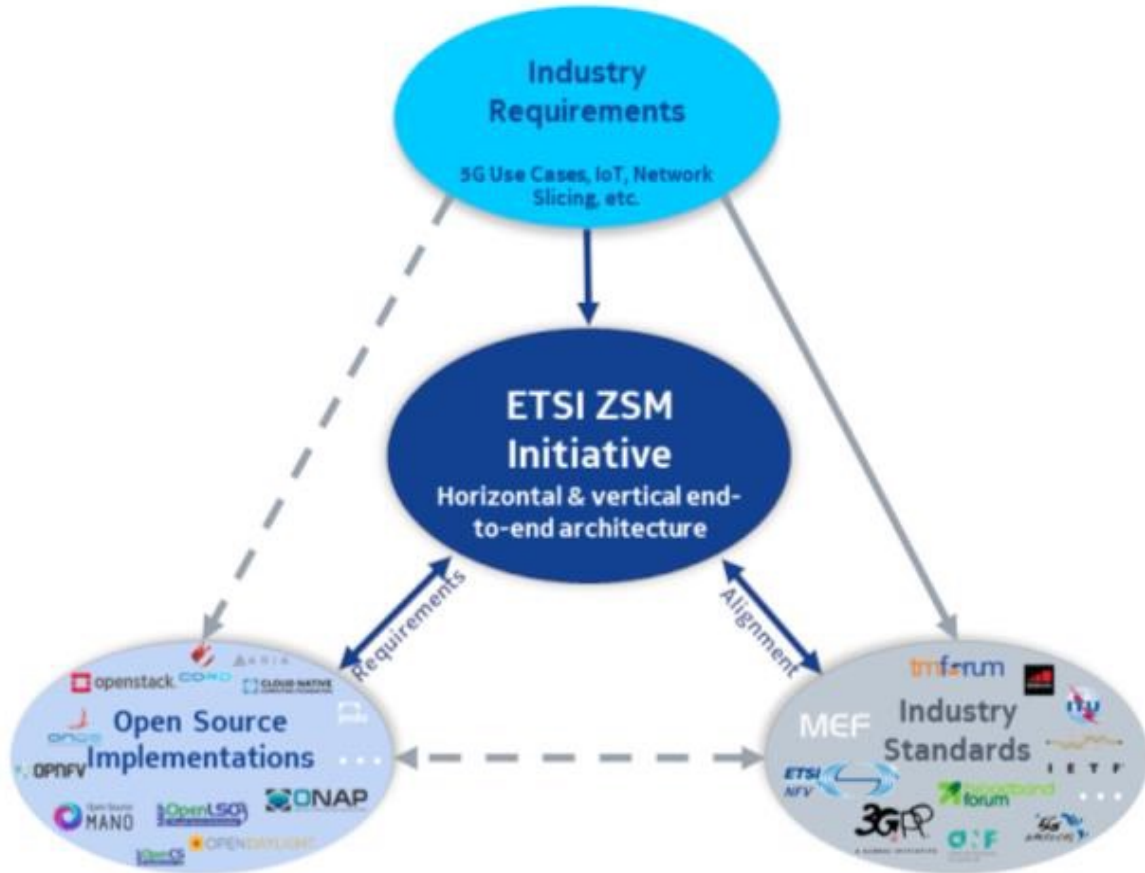


OODA – Observe, Orient, Decide, Act - Closed Control Loop

# Future Mobile Operator Architecture



# ETSI Zero Touch Network and Service Management (ZSM)



- ETSI Zero touch network and Service Management (ZSM) has a pivotal role in bridging between holistic end-end automation and other standardization bodies or open source projects
  - Requirements derived from use cases
  - Architecture for management/automation
- Open-source projects like ONAP should focus on implementation and validation
- Alignment discussion with LNF and ONAP

# ZSM: Automation based on Closed Loops

(Source: ETSI GS ZSM002)

- **Domain orchestration services**
- Automate workflows and processes to handle instantiation and lifecycle management of the services provided by the domain.

## Domain intelligence services

Provide domain-specific decisions and recommendations, to drive domain-level closed-loop automation.

Decide

## Domain analytics services

Provide domain-specific insights based on data collected by domain data collection services and on other data.

Orient

## Domain control services

Individually steer the state of each managed entity (resource, consumed service).

Act

## Domain data collection services

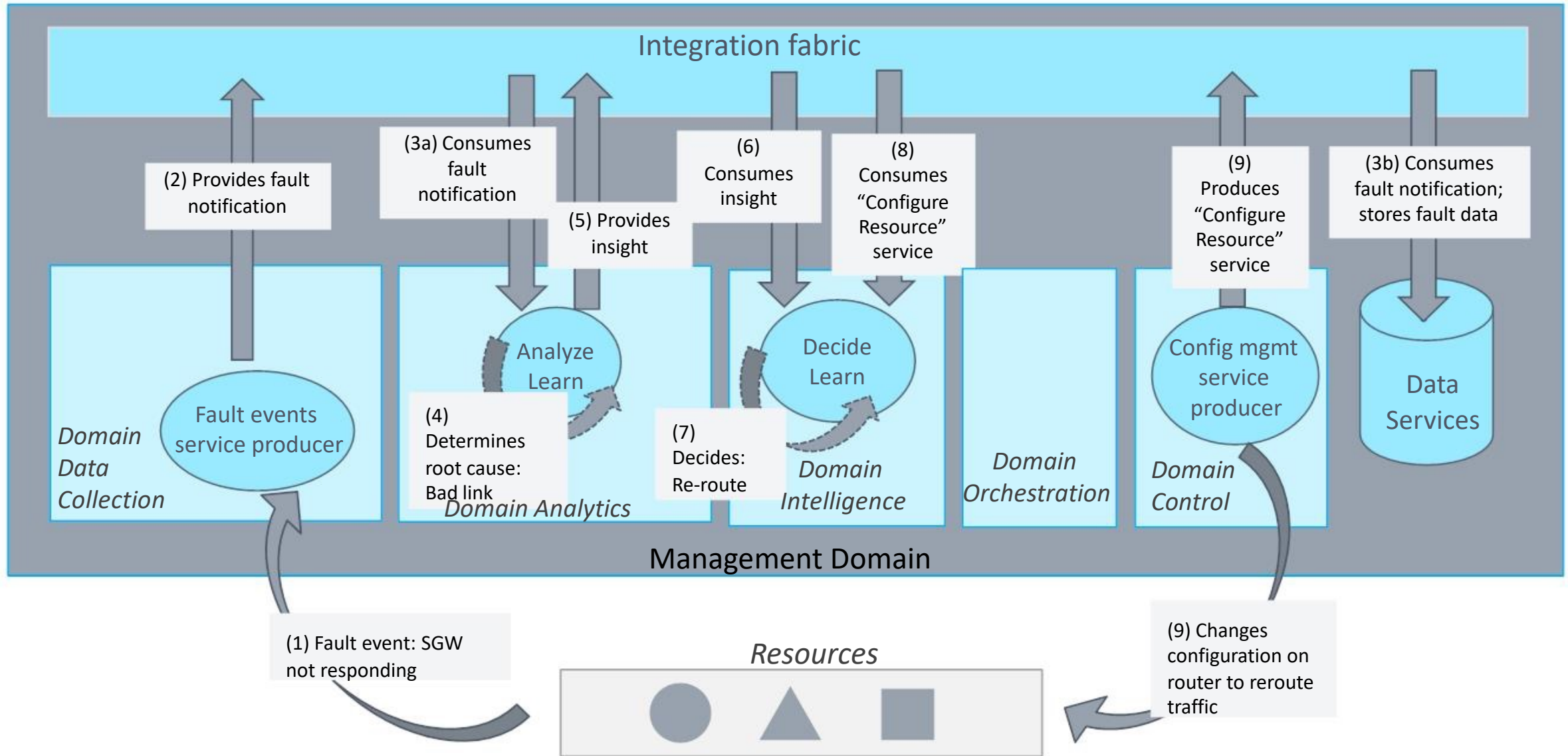
Monitor the managed entities (resources and consumed services), and provide live performance and fault data to support closed-loop automation.

Observe

OODA



# Closed loop example: Automatic fault mitigation



# Intent-based Networking / Automation

Closing the loop between intent and outcome

